Original Article

# Changes in choroidal thickness after prophylactic iridectomy in primary angle closure suspect eyes using enhanced depth imaging optical coherence tomography

*Wei Wang, Minwen Zhou, Wenbin Huang, Xinbo Gao, Xiulan Zhang*

**Purpose:** The aim of the present study was to evaluate the effect of surgical peripheral iridectomy (SPI) on choroidal thickness in primary angle-closure suspect (PACS) eyes. **Materials and Methods:** This was a prospective observational case series of 30 subjects with PACS. Ocular biometry was performed before SPI (baseline) and then 1 week later. Choroid was imaged by enhanced depth imaging optical coherence tomography (EDI-OCT). The choroidal thickness of the subfoveal area at 1 and 3 mm diameter around the fovea was determined. Central anterior chamber depth (ACD), lens thickness (LT), vitreous chamber depth (VCD), and axial length (AL) were measured by A-scan ultrasound. Parameters were compared before SPI (baseline) and 1 week later. **Results:** Thirty eyes of 30 patients with mean age of 61.53 ± 7.98 years were studied. There was no significant difference in the choroidal thickness at all macular locations before and after SPI (all $P > 0.05$). Mean subfoveal choroidal thickness was 279.61 µm ± 65.50 µm before and 274.54 µm ± 63.36 µm after SPI ($P = 0.308$). There was also no significant change in central ACD, LT, VCD, and LT after SPI (all $P > 0.05$). **Conclusions:** SPI does not appear to alter choroidal thickness in PACS eyes, as assessed using EDI-OCT. Long-term follow-up of PACS eyes treated with SPI may provide further insight into the effects of this treatment modality on the choroid.

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Primary angle-closure glaucoma (PACG) is a leading cause of blindness.[1] In 2020, it is predicted that PACG prevalence will reach 21 million, with roughly 5 million bilaterally blind cases.[1] Population-based studies have shown that PACG has a greater prevalence in persons of Asian ethnicity than in Europeans and Africans.[2,3] Chinese populations are reported to represent one of highest rates of PACG. In China, PACG accounts for 91% of bilateral glaucoma blindness, and 28 million people are classified as PACSs, the anatomical trait predisposing to PACG.[1] In a population-based study, 22% of PACS patients progressed to PAC, and 28.5% of PAC patients developed PACG within 5 years, if no treatment was given. Early detection by effective screening and appropriate prophylaxis may prevent blindness from angle-closure glaucoma. Ocular biometric studies have shown that eyes with PACG have several different characteristics as compared to normal eyes, such as a flatter cornea, shallower anterior chamber, thicker lens, shorter axial length (AL), and thicker choroid.[4-7]

The choroid is a vascular compartment which provides oxygen and nourishment to the outer retina, it plays a vital role in the pathophysiology of many conditions, such as glaucoma,[8,9] myopia,[10] central serous chorioretinopathy,[11] age-related macular degeneration,[12] and others. With the growing evidence regarding the involvement of choroid in glaucoma, it has become increasingly important to visualize the choroid in anatomic detail. Enhanced depth imaging optical coherence tomography (EDI-OCT) is a modification of the standard spectral-domain OCT (SD-OCT) technique that enables better noninvasive imaging of the choroid.

Surgical peripheral iridectomy (SPI) is used to resolve pupillary block by making a new shunt of aqueous flow from the posterior chamber to the anterior chamber, and is recognized as the mainstay of acute and chronic angle-closure glaucoma treatment until the advent of modern laser peripheral iridotomy (LPI). Previous randomized controlled trials found no significant difference between the SPI and LPI in efficacy and safety.[13] Although, in recent years LPI has become the first-line treatment of APAC, SPI was chosen in our hospital due to the limitation of hospitalization insurance in China.[14] At present, SPI is routinely performed in PACS eyes. Previously, we measured choroidal thickness in angle-closure glaucoma.[6-8] However, the effects of SPI on the choroid have not been evaluated to date. This study aimed to assess the effects of SPI on choroidal thickness in PACS eyes using EDI-OCT.

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## Materials and Methods

### Ethics statement

This was a prospective observational case series. The study had the approval of the ethics committee of a local institution and was performed according to the tenets of the declaration of Helsinki. The written informed consent was obtained from each subject after the aim, and the possible risks of the study had been explained fully.

### Subjects' enrollments

PACS subjects examined by a single glaucoma specialist and meeting the inclusion criteria were consecutively enrolled. Demographic characteristics and ophthalmic data were recorded for each subject.

The following criteria were used to define cases of PACS: (1) The presence of iridotrabecular contact in at least 180° of the angle circumference; (2) without synechial changes on gonioscopy with intraocular pressure (IOP) below 21 mmHg; and (3) normal optic disc appearance.[15] When both eyes of the same patient were eligible, one eye was randomly selected by a computer-generated randomization scheme. Exclusion criteria were the presence of peripheral anterior synechia, IOP exceeding 21 mmHg, optic disc changes suspicious of glaucoma, history of intraocular surgery, and inability to fixate for the OCT examination.

### Procedure

All subjects underwent a complete ophthalmic examination, including best-corrected visual acuity testing, IOP measurement (Goldmann tonometry), gonioscopy, fundus examination, UBM, and B-scanning. They also underwent a refractive error examination with an autorefractometer (KR-8900 version 1.07, Topcon Corporation, Tokyo, Japan). A-scan ultrasound (CINESCAN; Quantel Medical, France) was used to measure the central anterior chamber depth (ACD), lens thickness (LT), vitreous chamber depth (VCD), and axial length (AL). EDI-OCT examinations were performed by a single experienced ophthalmologist masked to the clinical diagnosis of the patient in the morning, always around 10 AM to avoid diurnal variations. SPI was performed under topical anesthetic, and general or subconjunctival or retrobulbar local anesthetic was not used. SPI was performed using a corneal section, leaving the conjunctiva undisturbed. A small knob of the peripheral iris was grasped with forceps, drawn out of the wound, and excised with micro scissors. The wound was sutured with a single 10–0 nylon suture. The PI was placed superiorly close to the vertical meridian. Full thickness perforation was confirmed. After SPI, all patients received betamethasone eye drops 4 times a day for 5 days. One week after SPI, all patients underwent a complete ocular examination including funduscopy with dilated pupil, A-mode ultrasonography, and OCT examination.

### Optical coherence tomography imaging

The choroidal images were obtained by a Heidelberg Spectralis SD-OCT (Heidelberg Engineering, Heidelberg, Germany; SD-OCT) with an EDI model. The standard protocol for obtaining EDI-OCT images was reported previously.[6-8] Briefly, the choroid was imaged by positioning an OCT device close enough to the eye to obtain an inverted image. The resultant images were viewed and measured using Heidelberg Eye Explorer software (version 1.7.0.0; Heidelberg Engineering, Heidelberg, Germany). The choroidal thickness was measured manually as the distance between the basal edge of the retinal pigment epithelium and the chorioscleral border. It was measured at nine points: Beneath the fovea, and the superior, inferior, temporal, and nasal sectors of 1 and 3 mm diameters [Fig. 1]. These measurements were performed by a single doctor who was blinded to the diagnosis and identity of the patients.

### Statistical analysis

To present data, the mean, standard deviation, and 95% confidence intervals were used in the analysis. As the Kolmogrov–Smirnov test did not show any deviation from normality in the distribution of data, the paired *t*-test was used to analyze differences in study parameters before and 1 week after SPI. All statistical analyses were performed using the SPSS software version 20.0 (SPSS, Inc., Chicago, IL, USA). $P < 0.05$ was considered statistically significant.

## Results

Thirty-two Chinese subjects completed this study. One patient was excluded because a clear OCT image could not be obtained due to lack of clarity in the optical media. Another patient was excluded because the border between the choroid and sclera could not be visualized, although the optical media was clear. Finally, 30 PACS eyes with high-quality OCT images were analyzed. The demographic and baseline characteristics of the patients are summarized in Table 1. Mean age was 61.53 ± 7.98 years, and eight subjects (26.67%) were male. The mean spherical equivalent refractive error was 0.64 ± 0.96 diopters.

Table 2 shows the ocular biometric parameters in PACS eyes measured before SPI and then 1 week later. Mean IOP before and 1 week after SPI were 13.30 ± 3.00 and 13.86 ± 3.19 mmHg, respectively ($P = 0.481$). Mean central AL was 22.51 ± 0.69 mm before SPI and 22.42 ± 0.72 mm afterward ($P = 0.135$). Changes in ACD, LT, and VCD after SPI were also not statistically significant. There were no significant changes in choroidal

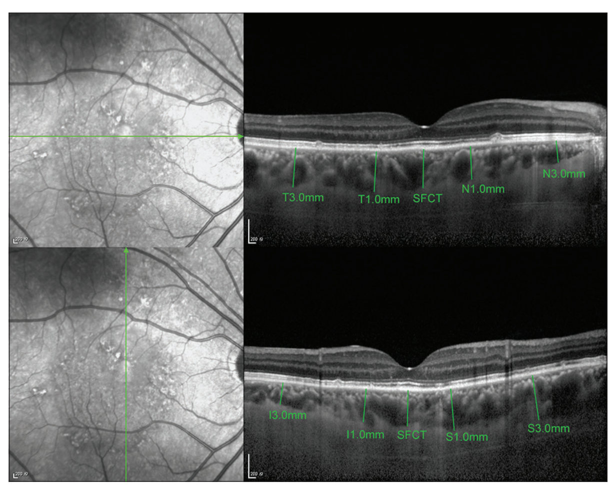


**Figure 1:** Illustration of the choroidal measurements by enhanced depth imaging optical coherence tomography. The choroidal thickness was measured at nine points; beneath the fovea, and the superior, inferior, temporal and nasal sectors of 1 and 3 mm diameters

thickness at any macular location 1 week after SPI compared with baseline values (all >0.05). The subfoveal choroidal thickness was 279.61 ± 65.50 µm at baseline and 274.54 ± 63.36 µm after 1 week ($P$ = 0.308).

## Discussion

Given that choroid has been shown to play an important role in the pathogenesis of PACG, the effects of SPI on the choroid may be clinically relevant. The aim of this study was to evaluate the effect of SPI on the choroidal thickness and other biometric parameters in PACS eyes. As far as we know, this is the first report of quantitative assessment of the changes in choroidal thickness after SPI using EDI-OCT. This study demonstrates that in the short-term, treatment with SPI does not alter choroidal thickness in PACS eyes. There was also no significant change in ACD, LT, VCD, or AL when compared before SPI and 1 week later.

Our findings are consistent with the results reported by Liu *et al*.,[16] which revealed that no significant changes in ACD after SPI in patients with primary acute angle closure glaucoma, by using anterior segment OCT. Our findings also are in agreement with previous studies that measured central ACD before and after an iridotomy.[17,18] One study reported no significant change in central ACD among PACS eyes after LPI during 2-years follow-up using UBM and A-scan biometry.[19] Li *et al*.[20] evaluated 37 eyes with Pentacam and concluded that LPI induces significant changes in anterior chamber volume, anterior chamber angle, and peripheral ACD in PACS and PAC; however, they found no significant change in central ACD. Faramarzi *et al*.[18] also found no significant change in central ACD, LT, and AL after LPI. In contrast to these studies, Dada *et al*.[21] described an increase in central ACD after LPI using UBM in 54 PAC eyes but not in the eyes with PACG. Our study showed that SPI in PACS eyes has no significant effect on central ACD though the peripheral ACD was found to increase, and eyes had a flatter peripheral iris configuration after iridectomy.

Recent interest has focused on the choroid as an important structure involved in the pathophysiology of PACG.[22] The introduction of EDI-OCT has provided the advantage of *in vivo* cross-sectional imaging of the choroid, similar to the retina. Quigley *et al*.[23] hypothesized that choroidal expansion is another mechanism for angle closure, and it may precede and even precipitate acute angle-closure. Although PACS eyes are prone to pupillary block, the pressure gradient between the anterior and posterior chambers is not enough to cause anterior movement of the crystalline lens in these eyes before SPI. Our study found no significant changes of choroidal thickness before and after SPI. This may be due to the inclusion of only PACS eyes. The PACS eye is a "silent" eye compared to the acute angle-closure eye. In acute angle-closure eyes, the expanded choroid may reduce significantly after SPI. Therefore, studies about the effect of SPI or LPI on choroidal thickness in acute angle-closure eyes are warranted.

There are certain limitations within this study that should be highlighted. First, the measurements of the choroidal thickness were performed manually, and automated software will be required for a more objective evaluation. Second, because the patients were recruited from a Tertiary Care Centre, the observed results may not be generalizable to the larger population. Third, our sample of 30 eyes may be too small to detect small effects of the variables that were evaluated. Finally, the 1-week follow-up may be too short. Previous studies on anterior segment OCT reviewed patients after 2–4 weeks.[16,24]

**Table 1: Demographic and baseline characteristics of subjects**

| Variables | Mean±SD | Range |
|---|---|---|
| Male (*n*) | 8 | |
| Female (*n*) | 22 | |
| Age (years) | 61.53±7.98 | 39-74 |
| Spherical equivalent (diopters) | 0.64±0.96 | −1-2.88 |

Data are presented as mean±SD or number. SD: Standard deviation

**Table 2: Comparison of ocular parameters before and after SPI**

| Parameters | Before SPI | After SPI | Change (95% CI) | *P** |
|---|---|---|---|---|
| IOP (mmHg) | 13.30±3.00 | 13.86±3.19 | −0.55 (−2.14-1.04) | 0.481 |
| AL (mm) | 22.51±0.69 | 22.42±0.72 | 0.09 (−0.02-0.20) | 0.106 |
| ACD (mm) | 2.32±0.30 | 2.15±0.32 | 0.17 (−0.06-0.39) | 0.135 |
| LT (mm) | 5.18±0.39 | 5.04±0.87 | 0.14 (−0.25-0.53) | 0.470 |
| VCD (mm) | 14.97±0.71 | 15.20±0.94 | −0.23 (−0.66-0.20) | 0.276 |
| SFCT (µm) | 279.61±65.50 | 274.54±63.36 | 5.07 (−4.95-15.10) | 0.308 |
| Superior 1 mm | 236.04±68.88 | 238.64±64.23 | −2.61 (−22.39-17.17) | 0.789 |
| Superior 3 mm | 227.61±72.93 | 226.29±65.19 | 1.32 (−13.64-16.28) | 0.858 |
| Inferior 1 mm | 230.21±64.69 | 224.32±55.68 | 5.89 (−7.82-19.61) | 0.386 |
| Inferior 3 mm | 195.46±76.16 | 201.39±75.70 | −5.93 (−24.47-12.61) | 0.517 |
| Nasal 1 mm | 235.25±88.60 | 233.29±79.71 | 1.96 (−14.23-18.16) | 0.805 |
| Nasal 3 mm | 177.18±69.35 | 181.79±71.00 | −4.61 (−26.56-17.35) | 0.670 |
| Temporal 1 mm | 246.64±83.89 | 237.86±63.57 | 8.79 (−6.23-23.80) | 0.240 |
| Temporal 3 mm | 245.29±62.96 | 247.86±64.57 | −2.57 (−25.42-20.28) | 0.819 |

*Based on paired *t*-test. IOP: Intraocular pressure, ACD: Anterior chamber depth, LT: Lens thickness, VCD: Vitreous chamber depth, AL: Axial length, SFCT: Subfoveal choroidal thickness, CI: Confidence interval, SPI: Surgical peripheral iridectomy

It may be possible that changes in choroidal thickness take longer than 1 week to become apparent. Therefore, studies with long-term follow-up, a larger number of eyes, and eyes with PACS, PAC, and PACG may provide a better insight on the long-term effects of SPI on the choroid.

## Conclusion

This study shows that SPI does not appear to alter choroidal thickness in PACS eyes in the short-term, as assessed using EDI-OCT. Long-term follow-up of PACS eyes and other angle-closure diseases treated with SPI or LPI may provide further insight into the effects of this treatment modality on the choroid at different stages within the spectrum of angle closure.

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### Conflicts of interest

There are no conflicts of interest.

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